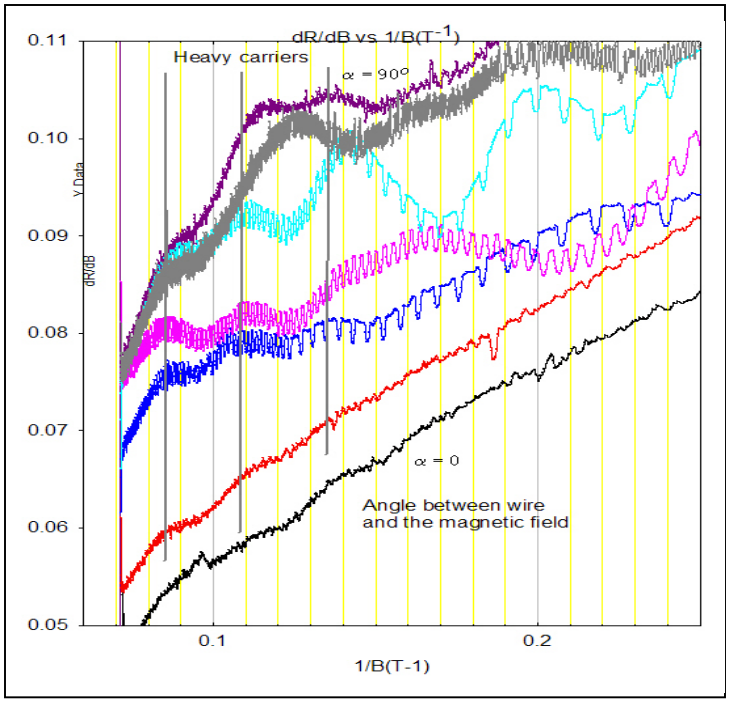
Whispering Gallery Motion and Fermi Surface of Charges in Bi Nanowires.I.
T.E. Huber, Howard University, DMR-0072847

Nanowires are ideally suited for compact nanoscale electronic devices, including the use of nanowire arrays for thermoelectric materials. However, many fundamental issues have yet to be resolved. We synthesize our samples using the technique of high-pressure, high-temperature injection into nanochannel dielectrics hosts (Templates were synthesized by a co-PI, C.Foss, Georgetown U.). Wire diameter ranges between 200 nm and 20 nm. The semimetal Bi is interesting because it has the smallest effective electron mass among all known materials, quantum confinement effects are more clearly manifested in Bi nanowires than in other materials. Also, Bi has unusually long electronic mean free path. We have discovered that the resistance show two types of oscillations as a function of magnetic field caused by the resonance of carriers in two types of orbits. At low magnetic fields we observe **whispering gallery** orbits in the wire periphery. At high magnetic fields we observed **Shubnikov-de Haas** where the orbit mirrors an orbit in momentum space around the Fermi surface. Sorting out these resonances requires, we have found, studies of the resistance as a function of angle between wire axis and magnetic field and very high magnetic fields (up to 16 T). The figure illustrates the results for 30 nm wires showing a heavy carriers corresponding to a piece of the Fermi surface that is caused by confinement. This excess charge would have to be compensated by impurity doping in order that the wires show intrinsic behavior as in the semimetal to semiconductor transition. This work was done in collaboration with the co-PI M.J. Graf at Boston College. Certain experiments were performed at the National High Field Magnetic Laboratory (NHMFL).



Whispering Gallery Motion and Fermi Surface of Charges in Bismuth Nanowires. II.
T.E. Huber, Howard U., DMR Award#0072847

Educational component:
5 undergrads,
1/2 grad students,
0 post-docs.
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Group of students working with the Atomic Force Microscope at the P.I.'s laboratory